

**A STUDY OF THE ECONOMIC PROPORTIONS OF
NON-PARALLEL CHORD STEEL
BRIDGE TRUSSES**

BY

ALY SALEM SHOUKRY

B.Sc., Fouad I University, 1940

M.Sc., Farouk I University, 1950



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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
ENGINEERING IN THE GRADUATE COLLEGE
OF THE UNIVERSITY OF ILLINOIS, 1953**

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A STUDY OF THE ECONOMIC PROPORTIONS OF NON-PARALLEL CHORD STEEL BRIDGE TRUSSES

Before the middle of the nineteenth century, the determination of the most favorable outline of bridges and other phases of their economic proportions were purely matters of judgment and experience. No method of analysis was then known. Since that time the question has been dealt with extensively, especially in the last few decades, on what we consider a more scientific basis. However, the question has not yet been thoroughly studied and still needs considerable investigation.

Many factors are involved in establishing the economic proportions of a bridge, and other matters such as, appearance, erection problems, distribution of metal, fabrication costs, details, maintenance and repairs, etc. require consideration. These factors may be very important but they are difficult of accurate evaluation and it is impossible to formulate most of them into mathematical expressions.

One of the important economic factors in bridge construction is the quantity of materials used in the structure. It is influenced greatly by the general proportions chosen for the main structural framework. In the case of truss bridges, the over-all dimensions of the main trusses, such as the depth of truss and the panel length for a given span have a considerable influence upon the weight of material in the superstructure.

The purpose of this investigation primarily is to establish the truss depth and panel length, which taken together, will result in the least weight of bridge for simple span, double-track, open-timber deck railroad bridges with polygonal chord Warren trusses.

Many articles and papers have presented mathematical equations, empirical formulas, charts and tables. Many such articles seem to be based on doubtful assumptions or state the weights as a function of span length only. Professor T. C. Shedd, on the basis of a series of expressions to estimate the least-weight depths of plate girders for different conditions originated an expression to be used to estimate the economical depths of trusses. However, as far as the writer has been able to determine, there is nothing in engineering literature about the economic proportions of trusses with polygonal chords except general statements.

To achieve the purpose of the present investigation designs were prepared for nine trusses as a preliminary step in establishing a method of selecting a consistent hip depth. These designs were then supplemented by designs for 72 additional trusses in which four panel lengths (25', 30', 35' and 40') and eight span lengths (240', 250', 280', 300', 320', 350', 360' and 400') were used. For each span length and panel length combination used, six or seven center depths varying by intervals of five to ten feet were studied and weights of trusses and bracing determined in pounds per foot of length per truss. The data obtained from these designs were then plotted in various ways to study the effect of changing center depth and changing panel lengths. They are also included in Appendices A and B of the thesis.

The studies led to the following conclusions:

1. The least hip depth compatible with adequate clearance and portal bracing is the most favorable from the standpoint of weight of trusses and bracing. However, in long spans so small a hip depth will contribute to undesirable reversal of stresses in diagonals and may be objectionable from that point of view. This point was not covered by this investigation and may be worthy of further study.

2. The center depth which leads to the least-weight of trusses and bracing is substantially one-quarter of the span length. Within the range covered by this investigation, this result appears to be independent of the panel length.

3. A deviation of as much as 10 to 12 percent from the theoretical least-weight depth at the center will cause a change in the weight of trusses and bracing of little if any more than two percent.

4. For any given span length there is a panel length which in combination with a favorable center depth (but independent thereof) leads to the least-weight of trusses, bracing and floor. Within the range studied, this panel length is given by:

$$p = \frac{L}{16} + 13.5'$$

in which p is the panel length in feet.

L is the span length in feet.

Deviations from this favorable panel length of as much as 10 to 12 percent will cause a change in weight of trusses, bracing and floor of not more than one to two percent.

5. The least-weight depths found in this investigation are very substantially greater than have been used in bridge trusses actually built in the past. An answer to the question of the relation between least-weight depth and economical depth would require a far more extensive investigation than this, one probably far beyond the possible scope of an academic thesis.

VITA

Aly Salem Shoukry was born in Cairo, Egypt, on July 7, 1918. Upon completion of his high school education at Khedevi Imal High School, Cairo, Egypt, in 1935, he was granted a scholarship by Fouad I. University. He became a student member of the Engineering Department in October, 1935, and in June, 1940, he was granted the degree of Bachelor of Science in Civil Engineering.

From September, 1940, to November, 1943, he served as an engineer in the Technical Office of the Surveying Department of Egypt. The work consisted mainly of Geodasy computations and field work in different branches of surveying.

He was next appointed Demonstrator in Surveying at Farouk University, Alexandria, Egypt, November, 1943. His promotion to Assistant Lecturer in the same department came in January, 1948. During the school year of 1949-1950, he had graduate courses in higher mathematics at Farouk University.

In February, 1950, he was granted leave of absence from Farouk University to enroll in the Graduate College of the University of Illinois. He completed the requirements for the degree of Master of Science in Civil Engineering in March, 1950, at Farouk University, and he was promoted to Lecturer B. He held a graduate Fellowship during the second semester of the school year 1951-1952. In February, 1952, he was promoted to Lecturer A at Farouk University.

His professional experience has included structural and bridge design for a bridge engineering company (New York) on a consulting basis, which was carried out during the last six months of 1952. He is a member of the Association of Professional Engineers of Egypt and Sigma Xi.

